# Autonomy support, light physical activity and psychological well-being in Rheumatoid Arthritis: A cross-sectional study

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# Autonomy support, light physical activity and psychological well-being in Rheumatoid Arthritis: a cross-sectional study

**Running title:** Correlates of light-intensity PA in RA

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## Abstract

**Background:** Participation in physical activity may improve psychological well-being among people with Rheumatoid Arthritis (RA). This study examined the implications of autonomy support for physical activity, on objectively assessed light physical activity *(LPA)* engagement, and in turn, psychological well-being in RA. In addition, the role of lower-limb functional disability in these associations was investigated. **Methods:** RA patients (N = 50) completed questionnaires assessing 1) autonomy support for physical activity [from a patient-specified important other], 2) functional disability to 'rise' and 'walk' (functional disabilityRW), 3) depressive symptoms, and 4) subjective vitality. Levels of LPA [100-2019 counts/minute], were calculated from 7-days of accelerometry. **Results:** Path analysis supported a model ($\chi^2$ (2) = 2.44, $p$ =.304, CFI =.99, SRMR =.05, RMSEA =.07) in which important other autonomy support for physical activity significantly and positively predicted LPA engagement. In turn, LPA was significantly and positively associated with subjective vitality, and significantly and negatively linked to depressive symptoms. These associations were observed independently of adverse direct relationships between Functional disabilityRW with depressive symptoms and subjective vitality. **Conclusions**: Important other autonomy support for physical activity may hold positive consequences for LPA engagement and related mental health states in RA, independent of the negative effects of lower-limb functional disability.



**Key words:** Functional disability, Autonomy support, Light physical activity, Accelerometer, Psychological well-being, Rheumatoid Arthritis.

## Introduction

Research underlines the benefits of regular participation in physical activity for promoting more optimal psychological health among both healthy adults and patient cohorts (Bauman, Merom, Bull, Buchner, & Fiatarone Singh, 2016; Cairns & McVeigh, 2009; Penedo & Dahn, 2005; Windle, Hughes, Linck, Russell, & Woods, 2010). People living with Rheumatoid Arthritis (RA) frequently report compromised psychological well-being (Gettings, 2010; Murphy, Sacks, Brady, Hootman, & Chapman, 2012). Thus, participation in physical activity may prove beneficial for enhancing psychological health in this patient group.

To date, the focus of RA studies has been on the psychological health benefits resulting from participation in physical activity above moderate intensity (i.e., ≥ 3 metabolic equivalents, METS) (Kelley, Kelley, & Hootman, 2015; Verhoeven et al., 2016; Windle et al., 2010). However, the reduced functional ability associated with RA, may restrict individuals' perceived ability to engage and subsequently, overtly participate in moderate intensity physical activity (Hernandez-Hernandez, Ferraz-Amaro, & Diaz-Gonzalez, 2014; Sokka et al., 2008; Veldhuijzen van Zanten et al., 2015). Conversely, participation in lower-intensity physical activities (i.e., light physical activity, 1.6 - 2.9 METS) may be perceived as relatively more feasible and achievable by people living with RA (Manns, Dunstan, Owen, & Healy, 2012), and is being increasingly advocated to improve overall health in several other clinical and ageing populations (Buman et al., 2010; Ekwall, Lindberg, & Magnusson, 2009; Larsen et al., 2014; Manns et al., 2012; Trinity, 2017). However, studies to date are yet to investigate the psychological health implications of engagement in light physical activity (LPA) for people living with RA, as well as factors that may influence engagement in this behaviour (i.e., determinants).

The social environment operating within physical activity settings has been proposed as a key determinant of physical activity behaviour. For example, Self-determination theory

(SDT), suggests where the social environment supports an individual's sense of autonomy with regards to their physical activity engagement (i.e., it promotes choice and understanding), this is more likely to encourage the adoption and maintenance of physical activity behaviour (Chan, Lonsdale, Ho, Yung, & Chan, 2009; Fortier, Duda, Guerin, & Teixeira, 2012; Milne, Wallman, Guilfoyle, Gordon, & Corneya, 2008). The social environment is largely created by the interpersonal behaviours of 'significant' or 'important' others acting within that setting. When considering physical activity in RA, this 'important other' could be the health care professional (e.g., rheumatology consultant, nurse, or GP) or other individuals the patient considers relevant to their attempts to be physically active (e.g., a spouse, offspring or friend) (Edmunds, 2007; Hardcastle, Blake, & Hagger, 2012; Williams, 2002).

Recent research revealed autonomy support for physical activity provided by 'important others', was linked to higher levels of self-reported total physical activity (comprising light, moderate and vigorous) among people living with RA (Yu et al., 2015). However, this study did not examine the role of autonomy support for LPA participation specifically, and a reliance on self-report somewhat limits the validity of these findings. Thus, research is required to investigate the implications of autonomy support for objectively assessed LPA engagement in RA, to determine whether the social environment represents a salient and modifiable determinant of LPA in these patients. In turn, investigating the extent to which variability in LPA (predicted by autonomy support) is associated with psychological well-being among people living with RA, will help to establish the potential value of interventions focused on creating autonomy supportive physical activity environments for improving psychological well-being among this patient group.

Upon investigating these associations, we must still consider the possibility that the compromised physical function symptomatic of RA may represent a barrier to even low-intensity physical activity engagement for these patients. Of particular relevance is functional disability related to standing and walking – two common light intensity activities. Indeed, walking is reported as the most common behaviour undertaken by people living with RA, and light intensity walking (including standing incidental and sporadic movement) comprises approximately 90% of ambulatory behaviour (Paul et al., 2014). Accordingly, an individual's disability related to 'standing' and 'walking' (i.e., lower-limb functional disability) should be taken into account when seeking to identify modifiable determinants of LPA participation in RA (e.g., the social environment).

The primary aim of this research was therefore to examine the implications of autonomy support for physical activity *and* lower-limb functional disability, for levels of objectively assessed LPA engagement, and associated positive and negative indicators of well-being in RA. Specifically, this study sought to examine the sequential associations between perceived autonomy support from a participant specified 'important other', lower-limb functional disability to 'rise' and to 'walk', accelerometer assessed LPA, and in turn, depressive symptoms and subjective vitality among people living with RA (Figure 1). These two outcomes are particularly pertinent to psychological functioning in RA. Specifically, depression represents a highly prevalent co-morbidity in RA (Ang, Choi, Kroenke, & Wolfe, 2005; Margaretten, Julian, Katz, & Yelin, 2011; Treharne et al., 2005), and subjective vitality provides an indication of an individuals overall optimal psychological functioning (Rouse et al., 2015; Ryan & Deci, 2001).

It was hypothesised that higher lower-limb functional disability (poorer function), would be negatively associated with LPA engagement. It was also expected that perceived 'important other' autonomy support would be *independently* and positively associated with LPA, and that LPA would be subsequently positively related to subjective vitality, and negatively associated with the prevalence of depressive symptoms (Figure 1). That is, we propose that autonomy support for physical activity predicts variability in LPA, to the degree it will hold positive implications for psychological well-being among people living with RA, after taking into account lower-limb functional disability.

## Methods

### Participants

Patients with RA were recruited as part of the xxxxx study (Trial Number:xxxxx). The xxxxx study was a randomised controlled trial, with the aim of promoting self-determined motivation for exercise engagement and improving cardiorespiratory fitness *(xxxx study reference)*. Baseline data were used to answer the current research questions. The study was granted ethical approved by the local National Health Service Research Ethics Committee (*reference:* xxxxx).

### Recruitment and protocol

Information sheets were distributed to interested participants attending Rheumatology outpatient clinics at xxxxx Hospital (xxxxx NHS Foundation Trust). In total, 115 participants (Mage = 53.98 ± 12.47 years) were recruited to the xxxxx study and provided informed consent. Questionnaire data were collected from participants during appointments at xxxxx Hospital. Following this, accelerometer data were collected over 7 days among a sub-subsample of willing participants (N = 97). The full xxxxx study protocol is detailed elsewhere *(xxxx study reference).*

### Measures

#### *Important other Autonomy Support for Physical Activity*

Important other support for physical activity (here-on referred to as autonomy support) was assessed using an adapted version of the Important Other Climate Questionnaire (IOCQ) (Williams et al., 2006). Participants were first asked to indicate who they consider to be the ‘most important person in their effort to engage in physical activity’ (e.g., a spouse, sibling, offspring, friend). Following this, participants responded to 6 statements regarding the degree of perceived autonomy for physical activity provided by their important other, as follows; 1) I feel that my important other has provided me with choices and options in regards to my physical activity, 2) I feel my important other understands how I see things with respect to my physical activity participation, 3) my important other conveys confidence in my ability to make changes regarding my physical activity participation, 4) my important other listens to how I would like to do things regarding physical activity, 5) my important other encourages me to ask questions about physical activity, 6) my important other tries to understand how I see my physical activity participation before suggesting any changes. Responses were given on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). The IOCQ demonstrated high internal reliability in this sample ($\alpha = .92$).

***Functional disability to 'rise' and 'walk'***

Participants' functional ability to *'rise'* and to *'walk'* (functional disabilityRW) was determined using the *'rising'* and *'walking'* subscales of the Stanford Health Assessment Questionnaire (HAQ) (Kirwan & Reeback, 1986) Following the stem, "Are you able to….", respondents were asked to rate on a scale from 0 (without any difficulty) to 3 (unable to do), the extent to which they are able to undertake functions related to *rising* (functions; 1) stand up from an armless straight chair and 2) get in and out of bed) and *walking* (functions; 1) walk outside on flat ground and 2) climb up five stairs). The score given to each subscale is the highest score reported across the two questions. Higher scores represent higher functional disability (i.e., poorer ability to 'rise' and 'walk'). A mean functional disabilityRW score was derived (to represent lower-limb functional disability), as the average score from the two subscales. Overall functional disability was also determined from the HAQ and is reported herein for descriptive purposes.

***Objectively assessed physical activity behaviours***

LPA was assessed using GT3X accelerometers (Actigraph). Participants wore the accelerometer on the right hip for 7 consecutive days, removing only for water-based activities (e.g., swimming and bathing) (Semanik et al., 2010; Trost, McIver, & Pate, 2005). The GT3X detected movements over sixty-second epochs in this study. Movement counts within each minute-epoch were summed and converted to activity counts that were interpreted to determine LPA engagement [i.e., ≥100 and <2020 counts per minute, (cpm)] (Troiano et al., 2008).

*Accelerometer data reduction*

Actilife software (version 6.2) was used to analyse the data. Data pertaining to waking hours [i.e., 7:00am–10:30pm - identified from visual inspection of graphical data (Tudor-Locke et al., 2015)], were downloaded and cleaned to check for spurious values and periods of non-wear. Non-wear time was determined by identifying strings of uninterrupted zero counts recorded by the accelerometer, for periods of > 60 minutes, allowing for 2 minutes of counts <100 (Troiano et al., 2008). Data were retained for subsequent statistical analyses where participants accumulated ≥10 waking hours wear, on ≥4 days, including a weekend day (Troiano et al., 2008). On this basis, N = 36 participants were excluded from analyses due to invalid accelerometer data. The outcome variable derived was minutes per day spent in LPA. To adjust for variability in accelerometer wear time, LPA min/day was converted to represent a % of daily accelerometer wear spent engaged in LPA (i.e., %LPA per day; [LPA (min/day) ÷ accelerometer wear time (min/day)] x 100).

***Psychological well-being***

*Depressive symptoms*

Depression is an independent risk factor for mortality among people living with RA (Ang et al., 2005; Treharne et al., 2005), and is estimated to affect up to 42% of this patient group (Margaretten et al., 2011). Prevalence of depressive symptoms was assessed using the depressive symptom subscale of the Hospital Anxiety and Depression Scale (HADS) (Zigmond & Snaith, 1983). The HADS requires patients to rate the extent to which they agree with 7 statements representing depressive symptoms (e.g., "I feel cheerful") via a 4-point scoring system (ranging from 0 to 3). The HADs has been validated previously in RA (Treharne, Lyons, Booth, & Kitas, 2007) and internal reliability of the HADS depressive symptom subscale in this study was acceptable ($\alpha = .81$).

*Subjective Vitality*

Subjective vitality (e.g., feeling alive, full of energy and spirit) provides an indication of the extent to which an individual is experiencing optimal psychological functioning – referred to as *eudaimonic* well-being (Rouse et al., 2015; Ryan & Deci, 2001). Subjective vitality is considered to have an internal locus of causality, which is influenced by both physical (e.g., rheumatic pain) and psychological factors. It is an individual's own perceived meaning behind these factors that determine the degree of energy, vitality and spirit felt. For people with RA, an individual's subjective vitality will therefore provide important information regarding their overall psychological functioning, within the context of their rheumatic disease.

Participants' feelings of personal energy were determined using the Subjective Vitality Scale (SVS) (Ryan & Frederick, 1997). Following the stem… "During the past 3-4 weeks, in my everyday life….", participants are asked to respond to 5 statements (e.g., "I feel alive and full of spirit") on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The SVS demonstrated high internal reliability in this study ($\alpha = .93$) and has recently been validated for use in RA (Rouse et al., 2015).

## Statistical analyses

Kolmogorov-Smirnov tests of normality were conducted and non-normally distributed data were log-transformed for use in subsequent analyses. Where transformations did not reduce data skewness (Kolmogorov-Smirnov, $p$ <.05, Table 1), non-parametric statistical tests were used in analyses as appropriate.

### *Preliminary analysis*

All preliminary analyses were conducted on participants providing valid accelerometer data (N = 61), using SPSS (version 22). Independent samples t-tests, Mann-Whitney U Tests and chi-squared tests confirmed that participants excluded on the basis of missing accelerometer data (N = 36) did not differ from those included in terms of age, gender, self-reported functional disabilityRW, perceptions of autonomy support, subjective vitality and depressive mood (all p's > .05).

Descriptive statistics were calculated and independent samples t-tests and correlation analyses conducted to examine whether participant sex and age, were associated with light physical activity and wellbeing variables. Where significant associations were observed, variables were adjusted for in path models.

### *Correlation analysis*

Bivariate correlations between autonomy support for physical activity, functional disabilityRW, light physical activity and positive/negative well-being outcomes were computed. In order to adjust for inter-participant variability in daily accelerometer wear-time, LPA was modelled as %LPA per day in both correlation and subsequent path analysis.

### *Path analyses*

Path analysis was employed to examine the associations between autonomy support, functional disabilityRW, LPA, depressive symptoms and subjective vitality. In brief, this approach involves stipulating hypothesised associations or 'paths' between variables of interest, in order to specify a causal model (e.g., Figure 1). The relationships specified within the model are then analysed simultaneously, to investigate the extent to which the current multivariate set of non-experimental data 'fits' with the hypothesised causal model. Analytically, this approach is an advance over correlation and traditional regression analysis as it enables exploration of how a set of variables relate to each other, including analysis of multiple dependent variables. For example, it allows us to examine if a hypothesised dependent variable (e.g., LPA), is also an independent variable for other dependent variables (e.g., vitality and depression). In addition, path analysis affords the ability to examine both direct *and* indirect effects. This means the possible indirect contribution of an independent variable on a dependent variable (e.g., via LPA) is not discounted where a direct association is not evident.

Path analysis with maximum likelihood estimation was employed in conjunction with the bootstrapping procedure to test the hypothesised model, as depicted in Figure 1. Previous research has shown this approach to be superior to alternative tests with respect to Type 1 error rates and power (Preacher & Hayes, 2008; Shrout & Bolger, 2002). Thus, it was deemed appropriate given the study sample size. Model fit was evaluated using the chi-square statistic ($\chi^2$), comparative fit index (CFI), root square mean error of approximation (RMSEA, 90% CI and PCLOSE], and standardised root mean square residual (SRMR). A non-significant $\chi^2$ ($p$ = < .05), a CFI >.90, and an SRMR and RMSEA of <.10 specify reasonable fit of the model to the data (Hu, 1999). For the RMSEA, a $p$ of close fit [PCLOSE] statistic >.05 also indicates a well-fitting model. In the instance where CFI is >.95, the model is considered to demonstrate excellent fit to the data. The strength and direction of path coefficients were also considered in assessing the validity of the models. Standardised path coefficients corresponding to (β =) 0.1, 0.3 and 0.5 were interpreted as small, medium and large effect sizes, respectively. Indirect effects were determined via examination of the bootstrap bias-corrected 95% confidence intervals. Specifically, the indirect effects of autonomy support and functional disabilityRW, on depressive symptoms and subjective vitality (via LPA) were examined.

All path analysis was conducted using AMOS (version 22). As required for AMOS path models, only data representing participants who provided complete valid data points for all targeted variables were retained for inclusion in path analyses (N = 50) (Arbuckle, 1999). Participants were excluded on the basis of invalid accelerometer data as previously described (N = 36), and a further N = 11 participants were excluded due to missing questionnaire data (SVS, N = 1, IOCQ, N = 10). Analyses established that participants excluded from path models on the basis of missing data (N = 47) did not differ from those included in terms of age, gender, self-reported functional disabilityRW, perceptions of autonomy support and depressive mood (all p's > .05). Mann-Whitney U Tests indicated levels of subjective vitality were significantly higher among included compared to excluded participants ($U = -2.06$, $p = .041$, effect size ($r$) = −.20).

## Results

### *Descriptive statistics*

Descriptive statistics for the targeted variables are reported in Table 1. Data are presented for the full sample recruited to the xxxxx study, and separately for those who provided valid accelerometer data (N = 61). Participants' providing valid data were largely female (67.2%) and white Caucasian (85.2%). Of these participants, 73.8% reported being married and/or living with a partner (9.8% single, 1.6% not living with partner, 6.6% divorced, 4.9% widowed, missing data = 3.3%), and 49.2% reported being in current employment (34.4% retired, 4.9% unable to work due to arthritis, 3.3% homemaker, 3.3% unemployed, missing data = 4.9%).

Results revealed a degree of functional disabilityRW of between 0 (without any difficulty) and 1 (with some difficulty) [*NB*: overall functional disability from eight HAQ dimensions, M ± SD = .67 ± .58]. On average, participants engaged in 4.5 hours of LPA per day and reported moderate to high levels of autonomy support for physical activity from their identified important other. Average prevalence of depressive mood was below the proposed clinical cut-off of ≥ 8 for probable depression, and subjective vitality was moderate to high for this sample of RA patients. Independent samples–tests and correlation analysis revealed participants' sex and age were not associated with LPA or wellbeing outcomes (all p's >.05, i.e., no adjustments were made for these variables in path models).

***Correlation analyses***

Results of bivariate correlations are displayed in Table 2. Analysis revealed perceptions of autonomy support were significantly positively related to %LPA engagement and subjective vitality, but were not significantly associated with depressive symptoms. Functional disabilityRW was not significantly related to %LPA engagement, but was significantly negatively related to subjective vitality, and significantly positively linked to depressive symptoms. Finally, a significant positive association was observed between %LPA and subjective vitality, and a significant negative relationship revealed between LPA and depressive symptoms.

***Path analysis***

*Hypothesised model:* The hypothesised model demonstrated a poor fit to the data ($\chi^2$ (5) = 22.29 $p$ =.000, CFI =.73, SRMR = .19, RMSEA =.27 (90% CI .00 to .26, PCLOSE = .16). Modification indices provided by AMOS (Arbuckle, 1999) were consulted in order to determine if there were problems with the hypothesised model that could be remedied in the context of the current data. Specifically, modification indices were used to identify associations between variables within the data set that were not currently specified within the hypothesised model. Aligned with recommendations regarding model re-specification, modifications to the hypothesised model were made *only* where relationships identified were conceptually justifiable based on previous research and theoretical assumptions (i.e., SDT) (MacCallum, 1995). Evaluation of modification indices demonstrated that re-specification of the model to stipulate direct paths from; 1) functional disabilityRW to depressive symptoms, 2) functional disabilityRW to subjective vitality, and 3) autonomy support to subjective vitality, would improve the fit between the model and the data. This is in agreement with results revealed in bivariate correlation analyses and consequently, the hypothesised model was revised and re-tested in accordance with these specifications (Figure 2).

*Re-specified model:* The revised model demonstrated an excellent fit to the data (Figure 2, $\chi^2$ (2) = 2.44 $p$ =.304, CFI =.99, SRMR = .05, RMSEA =.07 (90% CI .00 to .30, PCLOSE = .34). Results revealed autonomy support for physical activity significantly positively predicted %LPA engagement, which in turn, was significantly positively related to subjective vitality, and significantly negatively associated with depressive symptoms. Functional disability RW was not associated with %LPA engagement. All significant associations were of a small to moderate effect size ($\beta = \geq .2$ and $<.5$). Examination of $R^2$ values indicated autonomy support for physical activity accounted for 15% of the variance in %LPA ($R^2 = .15$). This subsequently predicted 4% of the variance in both subjective vitality and depressive symptoms ($R^2 = .04$).

*Indirect effects:* Perceptions of autonomy support demonstrated a significant negative indirect effect on depressive symptoms, ($\beta = -.12$, 95% CI: −.26 to −.02), and a significant positive indirect effect on subjective vitality ($\beta = .10$, 95% CI: .01 to .28) via LPA. No significant indirect effect of functional disabilityRW on depressive symptoms or subjective vitality via LPA was observed (depressive symptoms, $\beta = -.02$, 95% CI: −.13 to .06, subjective vitality, $\beta = .02$, 95% CI: −.05 to .13).

*Direct effects:* Model re-specification enabled investigation of direct effects; functional disabilityRW was significantly negatively associated with subjective vitality, and significantly positively associated with depressive symptoms, accounting for 18% and 23% of the variability in these outcomes, respectively (subjective vitality, $R^2$ = .18; depressive symptoms, $R^2$ = .23). Perceptions of autonomy support for physical activity were significantly positively associated with subjective vitality, predicting 16% of the variability in this outcome ($R^2$ = .16).

## Discussion

This cross-sectional study is the first to examine the relationships between autonomy support for physical activity, lower-limb functional disability, LPA engagement and indicators of positive and negative psychological well-being in RA. Results revealed that 'important other' autonomy support is beneficially linked to LPA engagement, and in turn, lower prevalence of depressive symptoms and higher subjective vitality in RA. These relationships were observed to be independent of the adverse role of self-reported functional disability to 'rise' and to 'walk' on psychological well-being states in these patients.

Past work has revealed autonomy support for physical activity to be positively associated with self-reported physical activity engagement among patient groups and the general population (Duda et al., 2014; Fortier et al., 2012; Milne et al., 2008). Previous research among older adults, has also demonstrated an association between objectively assessed LPA with indices of psychological well-being. (Buman et al., 2010; Rennemark, Lindwall, Halling, & Berglund, 2009). This study extends these findings in three ways. First, by providing new evidence of an association between autonomy support and objectively assessed LPA in RA. Second, by highlighting the potential role of LPA for fostering more optimal psychological well-being in this patient group. Finally, the analytical approach adopted permitted exploration of a hypothesised causal model, by which autonomy support may influence mental health states among people living with RA, via LPA engagement. That is, results suggest autonomy support from an ‘important other’ may encourage daily LPA participation to the extent it may impact positively on psychological health among people living with RA.

Our findings also revealed functional disability to ‘rise’ and ‘walk’, was not significantly associated with LPA engagement among this group of RA patients. This supports the contention that LPA (relative to moderate-intensity physical activity) may be more achievable for people with RA, despite the physical dysfunction symptomatic of this condition. However, whilst not related to LPA, lower-limb functional disability was observed to demonstrate direct adverse relationships with both subjective vitality (negatively) and depressive symptoms (positively). Results therefore substantiate findings from existing research, which demonstrate the deleterious consequences of functional disability for mental health in people living with RA (Benka et al., 2014; Wan et al., 2016) (van der Heide et al., 1994). Still, this study demonstrated autonomy support to be related to both subjective vitality (directly and via LPA) and depressive symptoms (via LPA), independently of the potential negative effects of lower-limb physical dysfunction on psychological functioning.

Establishing the independence of these associations not only improves our understanding of these relationships, but also serves to advance the management of RA outcomes, providing a framework for the development of effective interventions that aim to facilitate LPA and optimise psychological functioning in Rheumatic disease. Accordingly, when considering potential targets for interventions, strategies which ensure ‘important others’ are equipped with the skills to; support an individual’s choices with regards to physical activity engagement, provide a meaningful rationale (e.g., improved mental health) to encourage physical activity participation, and demonstrate understanding of an individual’s feelings/perspectives towards physical activity (Williams et al., 2006), may exhibit enhanced efficacy for encouraging LPA, and in turn, and improving psychological well-being in this patient group (Fortier et al., 2012; Ng et al., 2012).

Nevertheless, it is still important to consider the implications of current findings within the broader context of the xxxxx study. Participants recruited to this RCT were ready to engage in physical activity behavioural change – i.e., they were consenting to be prescribed (and undertake) an exercise programme to improve their cardiovascular health. Study participants therefore likely represent a cohort of RA patients at the 'preparation' stage of change in regards to their physical activity (Daley & Duda, 2006; Prochaska & DiClemente, 1983). It is possible that for individuals with RA who are not ready and preparing to initiate behavioural change (e.g., at the preceding pre-contemplation/ contemplation stages of change), autonomy support for physical activity may represent a less prominent determinant of LPA behaviour. Exploration of the extent to which an individuals 'readiness to change' may interact with social environmental factors and psychological well-being states in regards to their physical activity, represents an interesting avenue for future research.

Similarly, xxxxx study participants reported low-to-moderate functional disability, limiting the generalisabity of our findings to RA patients with more severe physical function. Moreover, we did not undertake clinical assessment of disease activity (i.e., Disease Assessment Score-28, DAS-28) to characterise the study sample. Studies employing the DAS-28 are required to confirm the extent to which autonomy support may contribute to more optimal mental health (via promoting LPA) among RA patients with more 'active' vs. 'controlled' disease.

Finally, the cross-sectional design of this study and small sample size should also be considered when interpreting current results. Specifically, compliance with the accelerometer protocol (63%) restricted the number of participants available for analyses, and the cross-sectional design limits the extent to which inferences can be made regarding causal direction of the associations examined. For example, it is possible that a patients' mood state (e.g., depressive symptoms) could influence their perceptions of autonomy support. However, results from experimental studies framed by SDT strongly support the directionality of the associations as investigated herein (Duda et al., 2014; Fortier et al., 2012; Teixeira, Carraca, Markland, Silva, & Ryan, 2012). In addition, the sample size is comparable with past research employing accelerometers coupled with questionnaires to investigate links between physical activity and self-reported health in RA (Khoja, Almeida, Chester Wasko, Terhorst, & Piva, 2016).

## Conclusion

Findings suggest that autonomy support for physical activity provided by an 'important other', is positively related to levels of LPA engagement among people living with RA. In turn, higher engagement in LPA is beneficially linked to lower prevalence of depressive symptoms and higher vitality in this patient group. These beneficial associations are observed independently of the adverse consequences of lower-limb functional disability for psychological well-being in RA. Results underline the importance of determining avenues through which 'important others' can be encouraged to provide autonomy support for physical activity among people with RA, in order to enhance mental health in this patient group.

# References

Ang, D. C., Choi, H., Kroenke, K., & Wolfe, F. (2005). Comorbid depression is an independent risk factor for mortality in patients with rheumatoid arthritis. *J Rheumatol, 32*(6), 1013-1019.

Arbuckle, J. L. W., W. (1999). *AMOS 4.0 user's guide*: SPSS Incorporated.

Bauman, A., Merom, D., Bull, F. C., Buchner, D. M., & Fiatarone Singh, M. A. (2016). Updating the Evidence for Physical Activity: Summative Reviews of the Epidemiological Evidence, Prevalence, and Interventions to Promote "Active Aging". *Gerontologist, 56 Suppl 2*, S268-280. doi:10.1093/geront/gnw031

Benka, J., Nagyova, I., Rosenberger, J., Calfova, A., Macejova, Z., Lazurova, I., . . . Groothoff, J. W. (2014). Social support as a moderator of functional disability's effect on depressive feelings in early rheumatoid arthritis: a four-year prospective study. *Rehabil Psychol, 59*(1), 19-26.

Buman, M. P., Hekler, E. B., Haskell, W. L., Pruitt, L., Conway, T. L., Cain, K. L., . . . King, A. C. (2010). Objective light-intensity physical activity associations with rated health in older adults. *Am J Epidemiol, 172*(10), 1155-1165.

Cairns, A. P., & McVeigh, J. G. (2009). A systematic review of the effects of dynamic exercise in rheumatoid arthritis. *Rheumatol Int, 30*(2), 147-158.

Chan, D. K., Lonsdale, C., Ho, P. Y., Yung, P. S., & Chan, K. M. (2009). Patient motivation and adherence to postsurgery rehabilitation exercise recommendations: the influence of physiotherapists' autonomy-supportive behaviors. *Arch Phys Med Rehabil, 90*(12), 1977-1982.

Daley, A., & Duda, J. L. (2006). Self-determination, stage of readiness to change for exercise, and frequency of physical activity in young people. *European Journal of Sport Science, 6*(4).

Deci, E. L., & Ryan, R. M. (1987). The support of autonomy and the control of behavior. *J Pers Soc Psychol, 53*(6), 1024-1037.

Deci, E. L., & Ryan, R. M. (2002). *Handbook of self-determination research*. Rochester, NY: University of Rochester Press.

Duda, J. L., Williams, G. C., Ntoumanis, N., Daley, A., Eves, F. F., Mutrie, N., . . . Jolly, K. (2014). Effects of a standard provision versus an autonomy supportive exercise referral programme on physical activity, quality of life and well-being indicators: a cluster randomised controlled trial. *Int J Behav Nutr Phys Act, 11*, 10.

Edmunds, J. N., N.; Duda, J.L.;. (2007). Adherence and well-being in overweight and obese patients referred to an exercise on prescription scheme: A self-determination theory perspective. *Psychology of Sport and Exercise, 8*, 18.

Ekwall, A., Lindberg, A., & Magnusson, M. (2009). Dizzy - why not take a walk? Low level physical activity improves quality of life among elderly with dizziness. *Gerontology, 55*(6), 652-659.

Fortier, M. S., Duda, J. L., Guerin, E., & Teixeira, P. J. (2012). Promoting physical activity: development and testing of self-determination theory-based interventions. *Int J Behav Nutr Phys Act, 9*, 20.

Gettings, L. (2010). Psychological well-being in rheumatoid arthritis: a review of the literature. *Musculoskeletal Care, 8*(2), 99-106.

Hardcastle, S., Blake, N., & Hagger, M. S. (2012). The effectiveness of a motivational interviewing primary-care based intervention on physical activity and predictors of change in a disadvantaged community. *J Behav Med, 35*(3), 318-333.

Hernandez-Hernandez, V., Ferraz-Amaro, I., & Diaz-Gonzalez, F. (2014). Influence of disease activity on the physical activity of rheumatoid arthritis patients. *Rheumatology (Oxford), 53*(4), 722-731.

Hu, L. B., P.M. (1999). Cut-off criteria for fit indexes in covariance structural equation analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*, 55.

Kelley, G. A., Kelley, K. S., & Hootman, J. M. (2015). Effects of exercise on depression in adults with arthritis: a systematic review with meta-analysis of randomized controlled trials. *Arthritis Res Ther, 17*, 21.

Khoja, S. S., Almeida, G. J., Chester Wasko, M., Terhorst, L., & Piva, S. R. (2016). Association of Light-Intensity Physical Activity With Lower Cardiovascular Disease Risk Burden in Rheumatoid Arthritis. *Arthritis Care Res (Hoboken), 68*(4), 424-431.

Kirwan, J. R., & Reeback, J. S. (1986). Stanford Health Assessment Questionnaire modified to assess disability in British patients with rheumatoid arthritis. *Br J Rheumatol, 25*(2), 206-209.

Larsen, R. N., Kingwell, B. A., Sethi, P., Cerin, E., Owen, N., & Dunstan, D. W. (2014). Breaking up prolonged sitting reduces resting blood pressure in overweight/obese adults. *Nutr Metab Cardiovasc Dis, 24*(9), 976-982.

MacCallum, R. C. (1995). Model specification: Procedures, strategies, and related issues. In R. H. Hoyle (Ed.), *Structural equation modeling: Concepts, issues, and applications* (pp. 16-36). Newbury Park, CA: Sage.

Manns, P. J., Dunstan, D. W., Owen, N., & Healy, G. N. (2012). Addressing the nonexercise part of the activity continuum: a more realistic and achievable approach to activity programming for adults with mobility disability? *Phys Ther, 92*(4), 614-625.

Margaretten, M., Julian, L., Katz, P., & Yelin, E. (2011). Depression in patients with rheumatoid arthritis: description, causes and mechanisms. *Int J Clin Rheumtol, 6*(6), 617-623.

Milne, H. M., Wallman, K. E., Guilfoyle, A., Gordon, S., & Corneya, K. S. (2008). Self-determination theory and physical activity among breast cancer survivors. *J Sport Exerc Psychol, 30*(1), 23-38.

Murphy, L. B., Sacks, J. J., Brady, T. J., Hootman, J. M., & Chapman, D. P. (2012). Anxiety and depression among US adults with arthritis: prevalence and correlates. *Arthritis Care Res (Hoboken), 64*(7), 968-976.

Ng, J. Y., Ntoumanis, N., Thogersen-Ntoumani, C., Deci, E. L., Ryan, R. M., Duda, J. L., & Williams, G. C. (2012). Self-Determination Theory Applied to Health Contexts: A Meta-Analysis. *Perspect Psychol Sci, 7*(4), 325-340.

Paul, L., Rafferty, D., Marshall-McKenna, R., Gill, J. M., McInnes, I., Porter, D., & Woodburn, J. (2014). Oxygen cost of walking, physical activity, and sedentary behaviours in rheumatoid arthritis. *Scand J Rheumatol, 43*(1), 28-34.

Penedo, F. J., & Dahn, J. R. (2005). Exercise and well-being: a review of mental and physical health benefits associated with physical activity. *Curr Opin Psychiatry, 18*(2), 189-193.

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behav Res Methods, 40*(3), 879-891.

Prochaska, J. O., & DiClemente, C. C. (1983). Stages and processes of self-change of smoking: toward an integrative model of change. *J Consult Clin Psychol, 51*(3), 390-395.

Rennemark, M., Lindwall, M., Halling, A., & Berglund, J. (2009). Relationships between physical activity and perceived qualities of life in old age. Results of the SNAC study. *Aging Ment Health, 13*(1), 1-8.

Rouse, P. C., Veldhuijzen Van Zanten, J. J., Ntoumanis, N., Metsios, G. S., Yu, C. A., Kitas, G. D., & Duda, J. L. (2015). Measuring the positive psychological well-being of people with rheumatoid arthritis: a cross-sectional validation of the subjective vitality scale. *Arthritis Res Ther, 17*, 312.

Ryan, R. M., & Frederick, C. (1997). On energy, personality, and health: subjective vitality as a dynamic reflection of well-being. *J Pers, 65*(3), 529-565.

Ryan, R. M., & Deci, E. L. (2001). On happiness and human potentials: a review of research on hedonic and eudaimonic well-being. *Annu Rev Psychol, 52*, 141-166.

Semanik, P., Song, J., Chang, R. W., Manheim, L., Ainsworth, B., & Dunlop, D. (2010). Assessing physical activity in persons with rheumatoid arthritis using accelerometry. *Med Sci Sports Exerc, 42*(8), 1493-1501.

Shrout, P. E., & Bolger, N. (2002). Mediation in experimental and nonexperimental studies: new procedures and recommendations. *Psychol Methods, 7*(4), 422-445.

Sokka, T., Hakkinen, A., Kautiainen, H., Maillefert, J. F., Toloza, S., Mork Hansen, T., . . . Group, Q.-R. (2008). Physical inactivity in patients with rheumatoid arthritis: data from twenty-one countries in a cross-sectional, international study. *Arthritis Rheum, 59*(1), 42-50.

Teixeira, P. J., Carraca, E. V., Markland, D., Silva, M. N., & Ryan, R. M. (2012). Exercise, physical activity, and self-determination theory: a systematic review. *Int J Behav Nutr Phys Act, 9*, 78. doi:10.1186/1479-5868-9-78

Treharne, G. J., Hale, E. D., Lyons, A. C., Booth, D. A., Banks, M. J., Erb, N., . . . Kitas, G. D. (2005). Cardiovascular disease and psychological morbidity among rheumatoid arthritis patients. *Rheumatology (Oxford), 44*(2), 241-246.

Treharne, G. J., Lyons, A. C., Booth, D. A., & Kitas, G. D. (2007). Psychological well-being across 1 year with rheumatoid arthritis: coping resources as buffers of perceived stress. *Br J Health Psychol, 12*(Pt 3), 323-345.

Trinity, J. D. (2017). Something is definitely better than nothing: simple strategies to prevent vascular dysfunction. *Clin Sci (Lond), 131*(11), 1055-1058. doi:10.1042/CS20170130

Troiano, R. P., Berrigan, D., Dodd, K. W., Masse, L. C., Tilert, T., & McDowell, M. (2008). Physical activity in the United States measured by accelerometer. *Med Sci Sports Exerc, 40*(1), 181-188.

Trost, S. G., McIver, K. L., & Pate, R. R. (2005). Conducting accelerometer-based activity assessments in field-based research. *Med Sci Sports Exerc, 37*(11 Suppl), S531-543.

Tudor-Locke, C., Barreira, T. V., Schuna, J. M., Jr., Mire, E. F., Chaput, J. P., Fogelholm, M., . . . Group, I. R. (2015). Improving wear time compliance with a 24-hour waist-worn accelerometer protocol in the International Study of Childhood Obesity, Lifestyle and the Environment (ISCOLE). *Int J Behav Nutr Phys Act, 12*, 11.

van der Heide, A., Jacobs, J. W., van Albada-Kuipers, G. A., Kraaimaat, F. W., Geenen, R., & Bijlsma, J. W. (1994). Physical disability and psychological well being in recent onset rheumatoid arthritis. *J Rheumatol, 21*(1), 28-32.

Veldhuijzen van Zanten, J. J., Rouse, P. C., Hale, E. D., Ntoumanis, N., Metsios, G. S., Duda, J. L., & Kitas, G. D. (2015). Perceived Barriers, Facilitators and Benefits for Regular Physical Activity and Exercise in Patients with Rheumatoid Arthritis: A Review of the Literature. *Sports Med, 45*(10), 1401-1412.

Verhoeven, F., Tordi, N., Prati, C., Demougeot, C., Mougin, F., & Wendling, D. (2016). Physical activity in patients with rheumatoid arthritis. *Joint Bone Spine, 83*(3), 265-270. doi:10.1016/j.jbspin.2015.10.002

Wan, S. W., He, H. G., Mak, A., Lahiri, M., Luo, N., Cheung, P. P., & Wang, W. (2016). Health-related quality of life and its predictors among patients with rheumatoid arthritis. *Appl Nurs Res, 30*, 176-183.

Williams, G. C. (2002). Improving patients' health through supporting the autonomy of patients and providers. In E. L. R. Deci, R.M. (Ed.), *Handbook of self-determination research* (pp. 232-254). Rochester, NY: University of Rochester Press.

Williams, G. C., Lynch, M. F., McGregor, H. A., Sharp, D., Deci, E. L., & Ryan, R. M. (2006). Validation of the "Important Other" Climate Questionnaire: Assessing autonomy support for health-related change. *Familes, Systems & Health, 24*, 15.

Windle, G., Hughes, D., Linck, P., Russell, I., & Woods, B. (2010). Is exercise effective in promoting mental well-being in older age? A systematic review. *Aging Ment Health, 14*(6), 652-669.

Yu, C. A., Rouse, P. C., Van Zanten, J. V., Metsios, G. S., Ntoumanis, N., Kitas, G. D., & Duda, J. L. (2015). Motivation-related predictors of physical activity engagement and vitality in rheumatoid arthritis patients. *Health Psychol Open, 2*(2), 2055102915600359.

Zigmond, A. S., & Snaith, R. P. (1983). The hospital anxiety and depression scale. *Acta Psychiatr Scand, 67*(6), 361-370